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APPLICATION OF REMOTE SENSING IN

THE STUDY OF VEGETATION AND SOILS IN IDAHO   (MMC #313-3)

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16. Abstract

1. Comparison of ERTS imagery and USGS 1-250,000 scale maps of study area with known ground points revealed significant map errors. These errors were sufficient to render impractical the projection of ERTS imagery directly onto maps of the area.

2. Marked differences were found in the delineation of ground features by different MSS bands. Generally, Band 4 was least useful, while Band 5 proved valuable for indicating patterns of native vegetation, cultivated areas - both dry and irrigated, lava fields, drainage basins and deep bodies of water. Band 6 was better for land forms and drainages and for shallow bodies of water than Band 5 but inferior for indicating patterns in native vegetation and most types of cultivated land. Band 7 was best of all for indicating lava flows, water bodies and landform features.

3. Use of an additive color viewer-projector aided greatly in separation of images. A combination of Bands 5 and 7 with appropriate color filters proved best for separating most types of native vegetation and cultivated crops. Landform features and water bodies also showed well with this combination. The addition of Band 4 imagery to the above further enhanced the identification of semi-dormant vegetation.

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Figure 2. Technical Report Standard Title Page

PREFACE

The primary objective of the project is to determine the usability of ERTS and U-2 multispectral imagery to inventory and monitor renewable natural resources, with particular emphasis on natural vegetation and associated subjects. Work to date includes indexing and first-look evaluation of all imagery received. Use of USGS topographic maps (scale 1:250,000) as base map was abandoned because of map error. Detailed examination and overlay tracings of observable images have been made of an area 100 miles x 300 miles at a scale of 1:250,000. Imagery projection was color enhanced to aid in image definition. Sagebrush, cheatgrass, and artificially seeded ranges were readily identified as well as woodland, dense forest and riparian vegetation. Irrigated farm areas were readily segregated from those where dryland cropping is practiced. Lakes, reservoirs, ponds and river channels were easily identified in MSS-7. In general, vegetational patterns are more discernible in MSS-5 than in other bands. Water bodies are best defined in MSS-7. Geologic features show up well in both MSS-5 and MSS-7. U-2 imagery provides considerable additional information and will be highly useful in separation of major sagebrush-grass types.

Imagery during the growing season (spring) should aid in the separation of range types on the basis of their moisture status. Cursory examination of U-2 imagery indicates that considerable additional information is provided and will be highly useful in separation of sagebrush range types, detection of good and poor land management practices, and for development of land use planning programs.

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REPORT

This report covers the first 6 months of activity on our ERTS-1 project. Progress has been accelerating after a slow start associated with lack of suitable facilities. Early work included indexing and cataloging the ERTS and U-2 imagery received, and a first-look evaluation of same. Most of the imagery contains less than 20% cloud cover, and some is cloud-free. The main limitation of the ERTS imagery received is the fact that it was taken after the bulk of the range vegetation was mature. This limitation also applies to the U-2 imagery, as the principal flight over our study area was made in October, 1972, although a shorter flight was made in the spring. Both ERTS and U-2 imagery have been requested for the spring and early summer of 1973 in order to remedy the above-mentioned deficiencies.

An early attempt to superimpose ERTS imagery over 1:250,000 USGS topographic maps proved unsatisfactory. Comparisons of relative lengths of sides of a triangular course were made between ERTS imagery and maps. Triangular courses were charted on two chips and corresponding topographic maps and measured. Perimeter distances of the charted triangles were 188 and 69 miles on the 2 maps, respectively. Triangulation was done with conspicuous points along shorelines of water bodies or confluences of rivers because of their sharpness and clarity, particularly on Band MSS-7. Measurements from ERTS imagery were obtained by viewing under a 7X binocular microscope equipped with a linear scale in the eyepiece. The relative length of each side of the triangle was calculated and the corresponding values obtained from ERTS imagery and map were compared.

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The results are summarized in Table 1. The average percentage difference was about 0.55%, with a maximum of 0.82%. The magnitude of difference was not proportionate to distance nor were the differences consistent in direction of disagreement. It appears that the maps were in error and not the projected ERTS images.

First-look evaluation of imagery by lantern slide projection produced a long list of identifiable images which are presented in Appendix A. The list reflects the diversity in landform, vegetation, and land use that occurs in the study area.

In viewing the black and white transparencies singly, some wave bands were naturally more useful in identifying images than others. Water bodies and geologic features were more readily identified in imagery produced in MSS-7 than in MSS-4 or 5, while natural vegetation and land use activity were more readily delineated in MSS-5. Evaluation of image clarity from individual bands of ERTS and U-2 imagery from selected chips is presented in Appendix B.

Substantial progress has been made in image mapping for ground truth checking. Tracing of images is accomplished with the use of a Spectral Data color additive viewer/projector. ERTS imagery is projected at a scale of 1:250,000 and all definable images are delineated on tracing paper. To date four overlapping chips (Image No. 1071-17524, 1072-17583, 1091-18044) have been studied in detail. These chips cover an area of about 100 miles by 300 miles. Copies of each overlay are reproduced by a blue printing process for field use. Legal land description boundaries are superimposed on one copy to facilitate location of delineated images for ground truth observation. Enlarged prints of ERTS imagery (1:500,000) and

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USGS quadrangle maps are used to locate roads and trails to reach specific areas for ground truth verification.

The second copy of mapped images is used to record the ground truthed image with reference to a detailed write-up of what is present. The delineated image may be further subdivided where a major change in species dominance occurs, even though not discernible in the image.

The third copy of images is used to record our interpretation of what is contained in the defined image before the area is checked for ground truth. This enables us to test our interpretative ability based on knowledge of vegetation and soils resources gained from previous ground-based studies.

The color additive viewer/projector greatly increases our ability to detect and delimit images. This is particularly true with use of Bands MSS-5 and MSS-7 with color filters. Separation of dryland from irrigated farming areas is easily accomplished with summer and fall imagery. Green crops (particularly sugarbeets, potatoes, irrigated alfalfa and pasture) are readily distinguishable from harvested and plowed fields due to their bright colors with color enhancement. Riparian vegetation as well as open woodland (Juniper type) and forests (ponderosa pine, Douglas-fir) are readily separated from adjoining semi-dormant or dormant vegetation composed of shrubs and herbs.

The combined imagery of Bands MSS-5 and MSS-7 brings out most of the observable features of geology, landform, water and vegetation. The addition of imagery from MSS-4 to the combination permits the use of 3 color filters that enhance the coloring of semi-dormant vegetation slightly more than when the MSS-5 & 7 combination is employed.

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Imagery obtained from U-2 flights taken at 65,000 ft. contributes much additional information. Highways and roads, and even jeep trails that criss-cross the range are traced with no difficulty when enlarged to 1:34,000 and enhanced with color. Although individual shrub or tree cannot be differentiated, differences in cover of natural vegetation are discernible. For example, grazed and ungrazed cheatgrass pastures as small as 5 acres can be detected by differences in image density. The boundaries of the encompassing 2,400-acre experimental range was not detected in ERTS imagery because of similarity of surrounding vegetation but was readily outlined in the U-2 imagery. In irrigated croplands, harvested strips as narrow as 100 feet were detected with little difficulty due to high color contrast between the growing crop and exposed soil. Cheatgrass range is readily separated from artificially seeded range.

Our experience with interpreting U-2 imagery is still cursory, but it appears that the added information will be highly usable in land use planning programs and management of natural resources. In addition, detection of poor resource management and unauthorized use of public lands can be done with ease. The combined information obtained from both ERTS and U-2 imagery is of particular value to Idaho because of its vastness, low population density and difficult access because of rough terrain and scarcity of roads.

Cooperative efforts for application of ERTS and other remote sensing imagery are being developed with (1) the Idaho State Fish and Game Dept. and (2) the U.S. Bureau of Land Management (Idaho Office). The Fish and Game Department desire to use remote sensing information for inventorying big game ranges in the state. This will involve identification and mapping of vegetation types over several million acres

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of terrain which is mostly rough and difficult of access. The B. L. M. staff are also concerned with recognition and mapping of major range types; also with monitoring burned areas, supplies of available stock water and grazing use, including trespass.

Technology

No new technology has been developed in this project to date.

Work Plans

Work plans for the next reporting period (May 1 to June 30) are as follows: Continue analysis of ERTS 1 and U-2 imagery in the laboratory. This will include preparation of additional monochrome and color prints for field checking, and a standardized method of recording checks on ground truth. Field work during this period (and for much of July and August) will involve checking for ground truth on a large number of points, and relating these to tentative maps of vegetation, soils and land use prepared from imagery available to date. A start will also be made at monitoring areas in different vegetation zones to test the value of ERTS imagery for detecting seasonal changes in phenology and soil moisture conditions.

Conclusions

Work to date on this project indicates:

(1) Ability of ERTS-1 imagery to distinguish major zones of vegetation (sagebrush, cheatgrass, salt-desert shrub, mountain brush) and land

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uses such as dryland cultivation, irrigated cultivation, range reseeding, range burns, etc.

(2) Effectiveness of ERTS imagery for distinguishing more subtle differences among vegetation types, such as different associations of sagebrush-grass range remain to be determined by relating differences shown by the imagery to ground truth.

(3) MSS Band 5 appears best for distinguishing different types of range vegetation and some cultivated land patterns, while Band 7 is best for other types of cultivated land, for most landform features and for bodies of water. Color enhancement with 2 or more bands gives additional differentiation for many features.

(4) U-2 imagery shows high potential for distinguishing different degrees of range condition and current grazing use. Suitability of ERTS imagery for these purposes is more doubtful, but worth further exploration.

(5) Available USGS standard topographic maps of much of the study area are not sufficiently accurate to allow us to use the technique of mapping by projecting ERTS imagery to scale on these map sheets.

Recommendations

To maximize the value of this project, the scope should be broadened to include applications to all types of land use in the area.

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Table 1. Comparisons of proportionate distances of triangular circuits obtained from ERTS imagery* and USGS topographic map (1:250,000) prepared by the Army Map Service.

Twin Falls (NK11-6)
Proportionate Distance (%)

Location	Imagery	Map	Diff.
A-B**	38.96	39.28	+.32
B-C	35.06	34.26	-.82
C-A	25.97	26.45	-.48
	99.99	99.99	Av. Diff.+.54%

Pocatello (NK12-4)

D-E	48.10	48.64	+.54
E-F	32.07	32.35	+.28
F-D	19.83	19.01	-.82
	100.00	100.00	Av. Diff.+.55%

* ERTS E - 1072-17583-7   with Twin Falls (NK11-6)
   ERTS E - 1034-17470-7   with Pocatello (NK12-4)

** A = C.J. Strike Dam
    B = Pioneer Reservoir
    C = Confluence East Fork of Bruneau with Main Bruneau River
    D = Lake Walcot Dam
    E = American Falls Res. Dam
    F = Confluence Raft River with Snake River

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APPENDIX A

IMAGE DESCRIPTORS

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UN 259

ERTS IMAGE DESCRIPTOR FORM
(See Instructions on Back)

DATE __March 7, 1973__

PRINCIPAL INVESTIGATOR __E. W. Tisdale__

GSFC __UN 259__

ORGANIZATION __University of Idaho__

NDPF USE ONLY
D ____
N ____
ID ____

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS* sage-brush	cheat-grass	irriga-tion	DESCRIPTORS
1072175835	X	X	X	Ridge
				Dryland farm
				Sugar beet
				Flood plain
				Arete
				Horn
				Col
				Tarn
				Meandering stream
				Braided stream
				Incised meander
				Dendritic drainage
				Plowed field
				Loess deposit

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

MAIL TO   ERTS USER SERVICES
             CODE 563
             BLDG 23 ROOM E413
             NASA GSFC
             GREENBELT, MD. 20771
             301-982-5406

GSFC 37-2 (7/72)

EXHIBIT II Typical Contract Schedule (Cont.)

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II-15

ERTS IMAGE DESCRIPTOR FORM
(See Instructions on Back)

DATE ___March 7, 1973___

PRINCIPAL INVESTIGATOR ___E. W. Tisdale___

GSFC ___UN 259___

ORGANIZATION ___University of Idaho___

				NDPF USE ONLY
				D ___
				N ___
				ID ___

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Range-land	Lava	Reser-voir	
1072175835	X	X	X	Airfield
				Alfalfa
				Conifer
				Crested wheatgrass
				Dormant vegetation
				Shadscale
				Riparian vegetation
				Playa
				Bajada
				Fault
				Forest
				Sink (lava)
				Dune
				Gorge
				Arroyo
				Cropland
				Dam
				Rectangular drainage
				Lake
				Potatoes
				Cirque
				River

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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II-15

ERTS IMAGE DESCRIPTOR FORM
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DATE __March 29, 1973__

PRINCIPAL INVESTIGATOR __E. W. Tisdale__

GSFC __UN 259__

ORGANIZATION __University of Idaho__

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS* Range- land	Agri- culture	Moun- tains	DESCRIPTORS
107117524-5	X	X	X	EEO lava flow (recent)
				Fissure zone (volcanic rift)
				Butte (volcanic)
				Lava plain
				Kipuka
				Badland
				Alluvial fan
				Bajada
				Floodplain
				Fault
				Fracture zone
				Fault block mtn.
				Graben
				Horst
				Ridge
				Canyon
				Arroyo
				Scabland (flood paths)
				Lava diverted river
				Braided stream
				Lineation
				Forest
				Reservoir

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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EXHIBIT II Typical Contract Schedule (Cont.)

II-15

ERTS IMAGE DESCRIPTOR FORM
(See Instructions on Back)

DATE _April 19, 1973_

PRINCIPAL INVESTIGATOR _E. W. Tisdale_

GSFC _UN 259_

ORGANIZATION _University of Idaho_

	NDPF USE ONLY
	D _____
	N _____
	ID _____

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS* Range-land	Agricul-ture	Moun-tains	DESCRIPTORS
107117522-5	X	X	X	Sagebrush
				Forests
				Fault zone
				Fracture Pattern
				Fault block mtn.
				Ridge
				Braided stream
				Canyon
				Arroyo
				Alluvial fan & apron
				Bajada
				Pediment
				Folded strata
				Inselberg
				Cirque
				Horn
				Gap (col)
				Tarn
				Reservoir
				Tree line
				Wetland
				Graben
				Drainage pattern

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

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EXHIBIT II Typical Contract Schedule (Cont.)

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II-15

ERTS IMAGE DESCRIPTOR FORM
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DATE __April 20, 1973__

PRINCIPAL INVESTIGATOR __E. W. Tisdale__

GSFC __UN 259__

ORGANIZATION __University of Idaho__

				NDPF USE ONLY
				D _____
				N _____
				ID _____

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*			DESCRIPTORS
	Range-land	Sage-brush	Agri-culture	
109118044-5	X	X	X	Plateau (lava)
				Plain (lava)
				Badland
				Fracture pattern
				Fault zone
				Lava flow
				Reservoir
				Forest
				Juniper
				Mountain
				Butte (volcanic)
				Mine tailing
				Canyon
				Arroyo
				Cumulus cloud
				Lava dammed lake
				Dendritic drainage
				Entrenched stream
				Urban area (city)
				Structural lineament

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GSFC 37-2 (7/72)

EXHIBIT II Typical Contract Schedule (Cont.)

APPENDIX   B

EVALUATION OF INDIVIDUAL BANDS OF ERTS I & U-2 IMAGERY

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EVALUATION OF INDIVIDUAL BANDS OF ERTS IMAGERY

MSS-4   Patterns in sagebrush vegetation due to past fires, abandoned lands and areas of varying density of sagebrush cover are not readily discernible. Boundaries of lava fields of varying ages are not sharply defined. Large bodies of water such as lakes and reservoirs are discernible but shallow bodies of water are difficult to detect. Boundaries of cultivated fields are not sharply defined as in other wave bands. Drainage patterns are usually difficult to trace.

MSS-5   Subtle patterns in the sagebrush that are vague in MSS-4 are much more pronounced, permitting easier delineation of images. Boundaries of recent and old surface exposed lava fields are much clearer than in MSS-4 imagery. Cultivated fields, both irrigated and dry farm areas, are readily delineated. Large bodies of water are easily seen, but shallow ponds and reservoirs are difficult to detect. Separation of forest vegetation from adjacent sagebrush vegetation is considerably easier to detect than in MSS-4. Greater contrast in imagery of MSS-5 permits easier detection and tracing of drainage patterns.

MSS-6   Pattern in sagebrush vegetation is not as sharply delineated as in MSS-5 but is better than with MSS-4. Lava fields show greater contrast with surrounding areas than in MSS-5 or MSS-4. Cultivated fields supporting green crops (sugar beets, potatoes, irrigated alfalfa and pasture) are not as readily separated from harvested fields as in MSS-5. Cultivated areas are readily distinguished from rangeland, however. Separation of forest

with sparse stands is more difficult than in MSS-5. Shallow ponds and reservoirs that were not readily detected in MSS-4 and MSS-5 are easily identified. Landform and drainage patterns are much more pronounced than in MSS-5 or 4.

MSS-7   Patterns in sagebrush vegetation are less detectable than in MSS-5 but similar to MSS-6. Lava fields are sharply distinguished as to age or composition. At least 4 different shades of grey, indicating differences in age of flows, are readily delineated in the Craters of the Moon area. Open forest is not sharply differentiated from adjacent natural vegetation as in MSS-5. Water bodies, both large and small, are best defined in MSS-7. Geologic and landform features are also best defined in MSS-7.

EVALUATION OF U-2 IMAGERY

475-575nm. Great detail is observable. Minor drainage patterns are readily seen. Reseeded areas are readily discernible, particularly those less than 10 years old. Older seedings retain their identity if sagebrush reinvasion is not extensive. Fields with crops show distinctly as various shades of grey. Recently plowed fields are light colored. Highways, streets, and county lanes are readily identified and traced with no difficulty. Roads that traverse the range are easily followed, including jeep roads that criss-cross the desert. Intermittent stream channels are easily seen, also changes in topography unless very gradual. Breaks in the landscape due to draws, ravines or gullies are easily detected. Normally vegetated

areas are easily separated from areas of sparse vegetation due to high reflectance of the soil surface. Recently burned areas are easily detected. Differences in soil types are readily traced in plowed fields due to difference in soil color and/or texture.

680-780nm. Croplands with late maturing crops such as sugarbeets, potatoes or irrigated alfalfa are light in color as contrasted with harvested fields. Soil body differences in plowed fields are not as easily delineated as in band 474-575nm. In natural vegetation, areas without accumulations of litter show up more readily than areas where fall green growth is masked by the presence of old growth and litter. Grazed and ungrazed cheatgrass pastures, as small as 5 acres, are easily distinguished, presumably due to the relative amounts of old growth remaining. Ungrazed or lightly grazed pastures show darker than those heavily grazed. Reseeded areas are easily separated from adjacent sagebrush vegetation.